Claims

What is claimed is:

1. A method for solving a finite element model corresponding to a system in which there is a multi-phase fluid flow comprising:

generating a finite element matrix corresponding to the model, wherein the matrix contains a plurality of coefficients;

adjusting the coefficients to obtain a matrix in which on-diagonal elements are non-negative and off-diagonal elements are non-positive; and

generating a solution for the model using the matrix using finite element techniques.

2. The method of claim 1 wherein adjusting the coefficients comprises weighting the nodes of each element according to a direction of fluid flow across the element.

3. The method of claim 2 wherein weighting the nodes of each element according to a direction of fluid flow across the element comprises determining the direction of fluid flow across the element and weighting each node more heavily if the node is upstream from the other nodes of the element and less heavily if the node is downstream from the other nodes of the element.

4. The method of claim 3 wherein each node is weighted more heavily if a greater portion of the element is downstream from the node than from other nodes of the element and less heavily

if a smaller portion of the element is downstream from the node than from other nodes of the element.

5. The method of claim 1 wherein the finite element matrix corresponds to a system in which there are at least two fluid phases.

6. The method of claim 1 wherein the finite element matrix corresponds to a system in which there are three or more fluid phases.

7. The method of claim 1 wherein the finite element matrix corresponds to a four-dimensional finite element model.

8. The method of claim 1 wherein the system corresponds to an oil reservoir.

9. The method of claim 1 wherein the matrix is configured to produce a solution which is not physically unrealistic at any time.

10. The method of claim 1 wherein the matrix is configured to produce a solution which is non-oscillating.

11. The method of claim 1 further comprising discretizing a model of the system to produce a finite element mesh and generating the matrix based on the finite element mesh.

12. A method for obtaining improved accuracy in solving finite element models comprising:

discretizing a model of a system in which there is a multi-phase fluid flow;

generating a finite element matrix corresponding to the model, wherein the matrix is configured to produce a solution which is monotonic and preserves linearity; and

generating a solution for the model using the matrix.

13. A computer-readable medium which contains a plurality of instructions, wherein the instructons are configured to cause a computer to perform the method for solving a finite element model corresponding to a system in which there is a multi-phase fluid flow comprising:

generating a finite element matrix corresponding to the model, wherein the matrix contains a plurality of coefficients;

adjusting the coefficients to obtain a matrix in which on-diagonal elements are non-negative and off-diagonal elements are non-positive; and

generating a solution for the model using the matrix using finite element techniques.

14. The computer-readable medium of claim 13 wherein adjusting the coefficients comprises weighting the nodes of each element according to a direction of fluid flow across the element.

15. The computer-readable medium of claim 14 wherein weighting the nodes of each element according to a direction of fluid flow across the element comprises determining the direction of fluid

flow across the element and weighting each node more heavily if the node is upstream from the other nodes of the element and less heavily if the node is downstream from the other nodes of the element.

16. The computer-readable medium of claim 15 wherein each node is weighted more heavily if a greater portion of the element is downstream from the node than from other nodes of the element and less heavily if a smaller portion of the element is downstream from the node than from other nodes of the element.

17. The computer-readable medium of claim 13 wherein the finite element matrix corresponds to a system in which there are at least two fluid phases.

18. The computer-readable medium of claim 13 wherein the finite element matrix corresponds to a system in which there are three or more fluid phases.

19. The computer-readable medium of claim 13 wherein the finite element matrix corresponds to a four-dimensional finite element model.

20. The computer-readable medium of claim 13 wherein the system corresponds to an oil reservoir.

21. The computer-readable medium of claim 13 wherein the matrix is configured to produce a solution which is not physically unrealistic at any time.

22. The computer-readable medium of claim 13 wherein the matrix is configured to produce a solution which is non-oscillating.

23. The computer-readable medium of claim 13 wherein the method further comprises discretizing a model of the system to produce a finite element mesh and generating the matrix based on the finite element mesh.